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AMMONIA CAPACITY : INCREASING OPTIONS

by

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KBR is one of the world's largest engineering contractors.

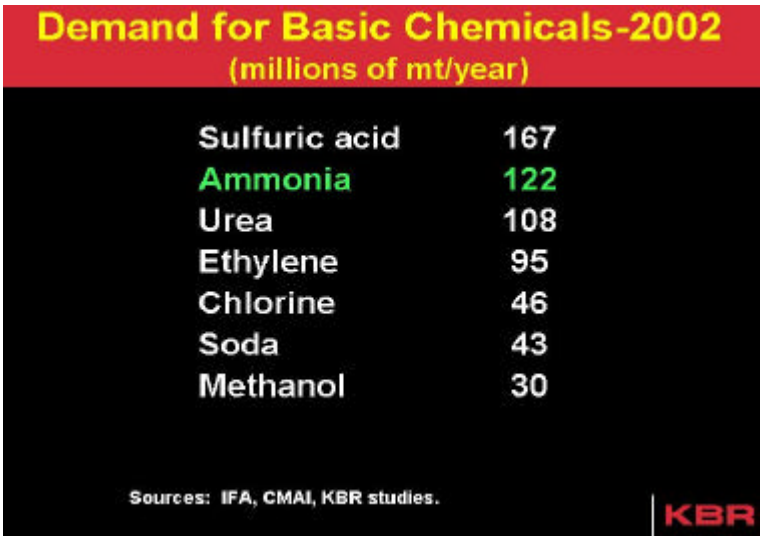
We have been involved in the fertilizer business for over 50 years. During that time span KBR has licensed more than 200 ammonia plants around the world, which accounts for over half the installed capacity.

My talk today will provide a contractor's and licensor's view on where the ammonia market is heading and the options available to producers for adding capacity.

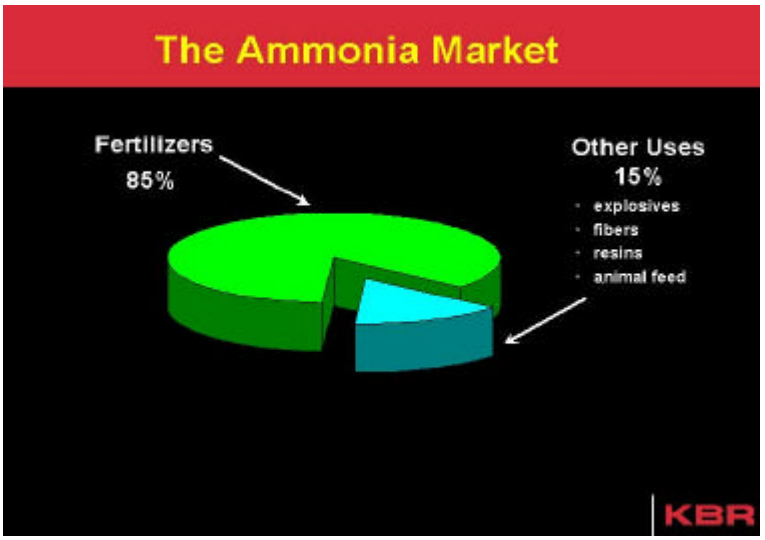
Topics to be covered :

- Ammonia market overview
- Capacity increases via revamp projects
- Capacity increases via new plants
- Summary

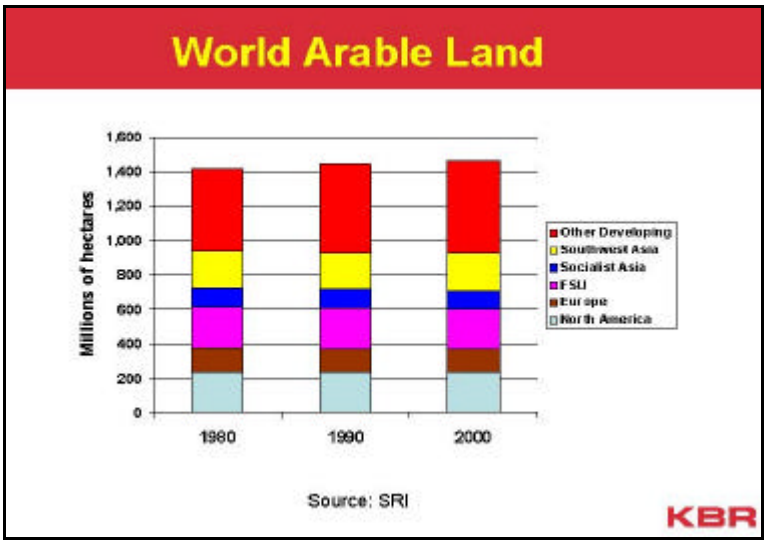
AMMONIA MARKET OVERVIEW



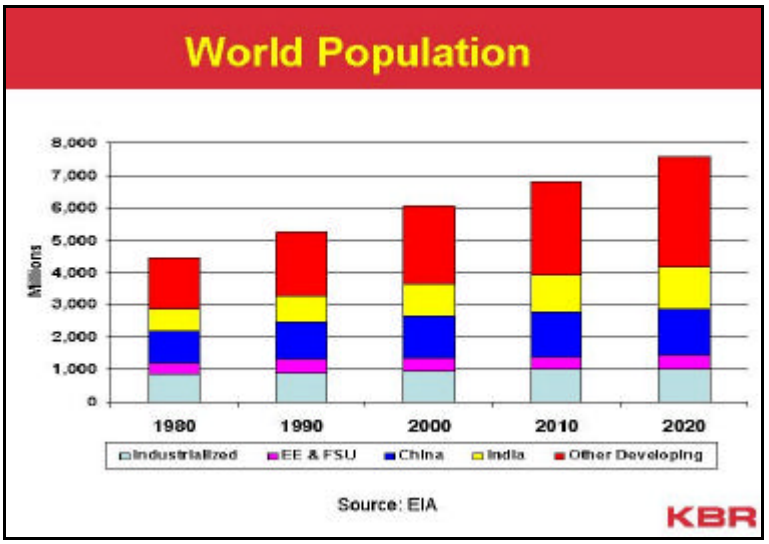
This slide shows the demand for the largest volume chemicals on a world-wide basis.
The fertilizer business accounts for the top three basic chemicals.



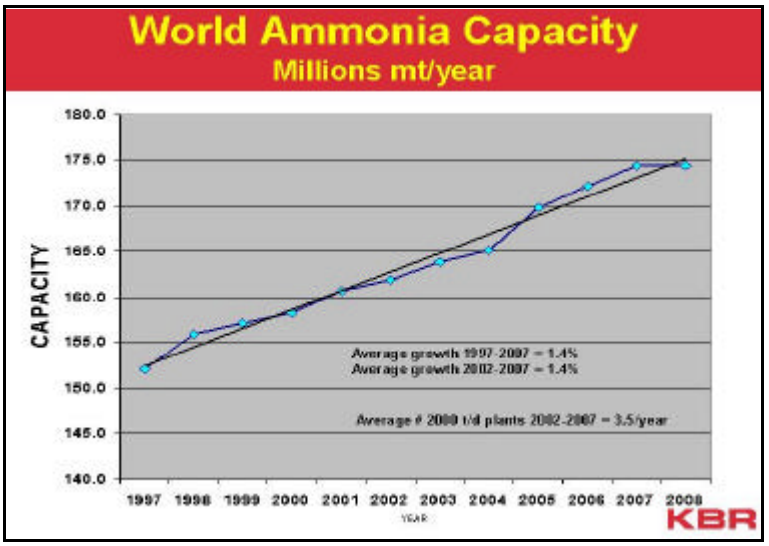
Ammonia demand is dominated by the fertilizer business, which consumes about 85 percent of the production.



The amount of arable land in the world has not increased significantly over the last 20 years.



Meanwhile we add about 1.5 billion people to the planet every 20 years. This population growth rate corresponds to 1.3 % per annum.

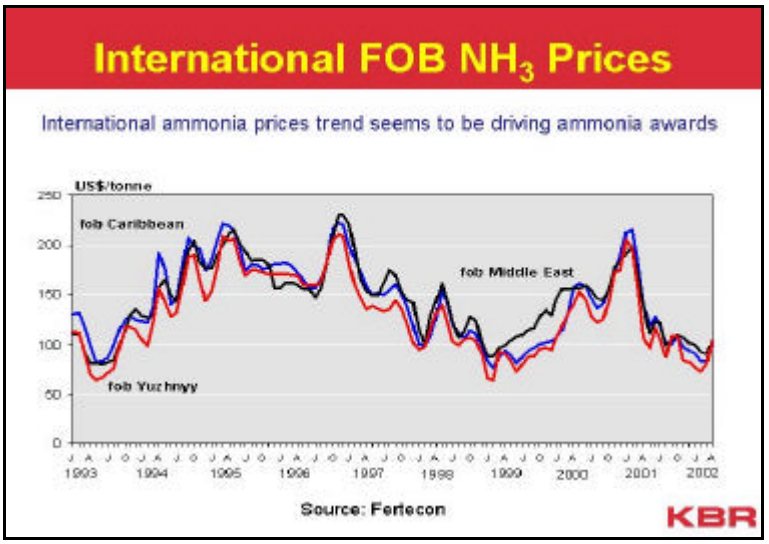


Ammonia plant capacity additions in recent years have been matching population growth. We expect this trend to continue.

From a contractor's point of view, we are interested in how many plants will be built. This growth trend translates to the equivalent of 3.5 new plants of 2000 mt/day capacity each year.

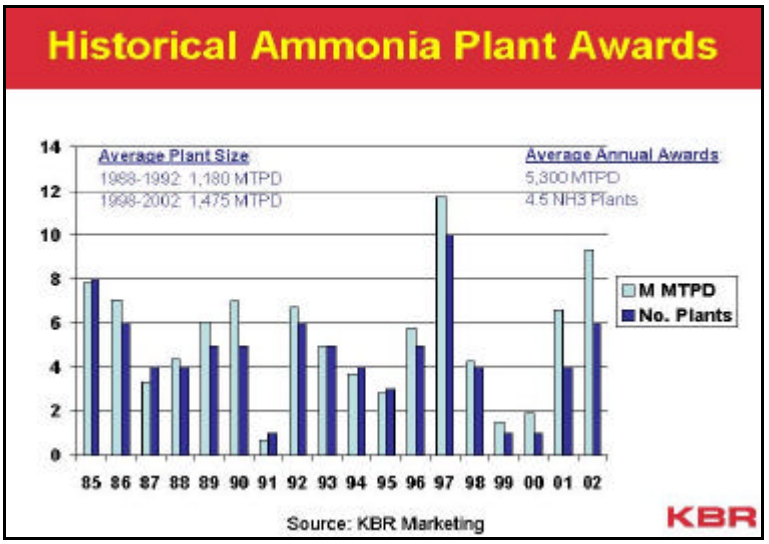
Note that this calculated number of new plants will be affected by :

1. Closure of uneconomic plants
2. Capacity creep due to debottlenecks
3. Capacity selected for new plants



The previous graph showed a fairly constant growth rate in capacity. In reality it is not so smooth. Capacity addition is strongly affected by ammonia price. As this graph shows, ammonia prices in the last 9 years have varied from less than $75/tonne to over $225/tonne.

The relatively high and sustained prices in the mid-1990s led to a construction boom, as shown on the next slide.



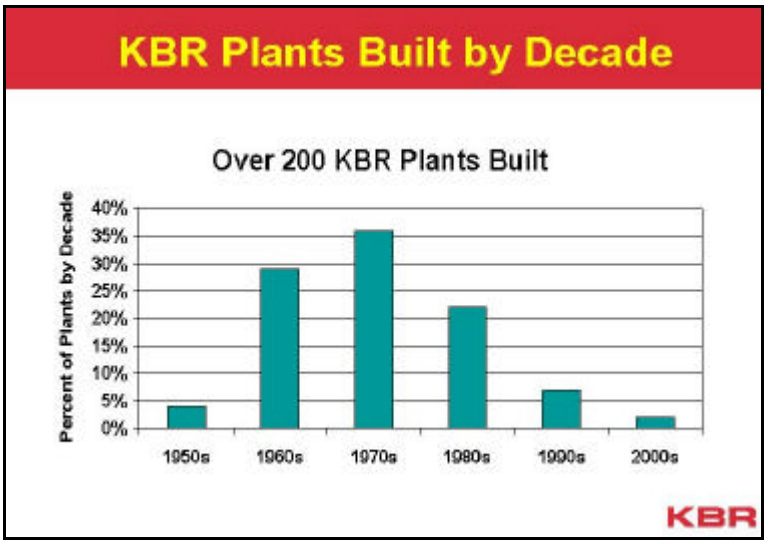
Looking back over the last 17 years, we see that there was an average of 4.5 ammonia plants awarded each year. In 1996 and 1997 there was a total of 15 awards in just these 2 years.

This slide also shows that the average capacity of new plants is trending up. I will discuss this trend later in the presentation.

With that background in the market, let's now turn our attention to how capacity is added. This next section of my presentation will discuss capacity addition through revamp projects.

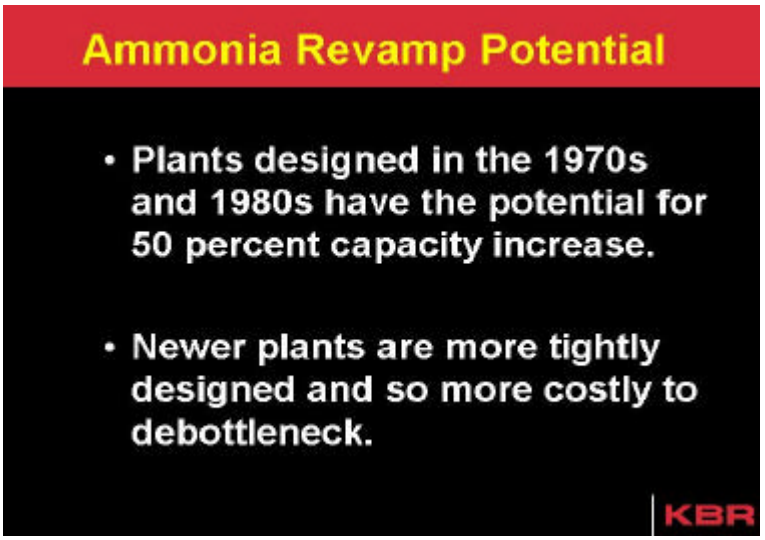
CAPACITY INCREASES VIA REVAMP PROJECTS

There are a number of reasons why ammonia plant operators decide to revamp a plant. All of the reasons have to do with keeping the plant economically viable. By far the most common reason is to increase capacity. It is often more economic to add capacity by revamping a plant than by building a new plant.



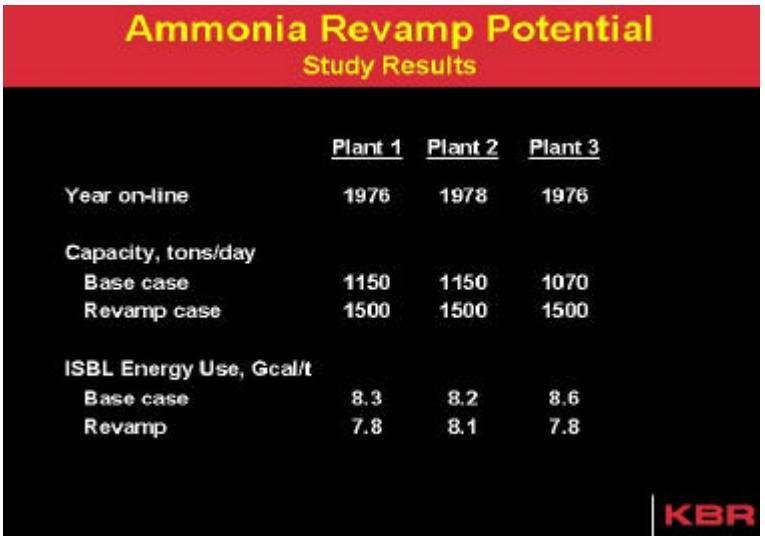
Since the advent of the large-scale, centrifugal plants, pioneered by KBR in the 1960s, about 400 such plants have been built. Over one-half of them were licensed from KBR. This graph shows the distribution of the plants licensed by KBR. As you can see there was a large amount of building from the 1960s through the 1980s. The effect of increasing plant size, to be discussed later, also influenced the decline in the number of plants in later years.

Many of the plants from the 1960s have been shut down. Operators with 1970s and 1980s vintage plants are struggling to stay competitive. This vintage represents about one-half of the plant population. Revamping is an obvious solution.

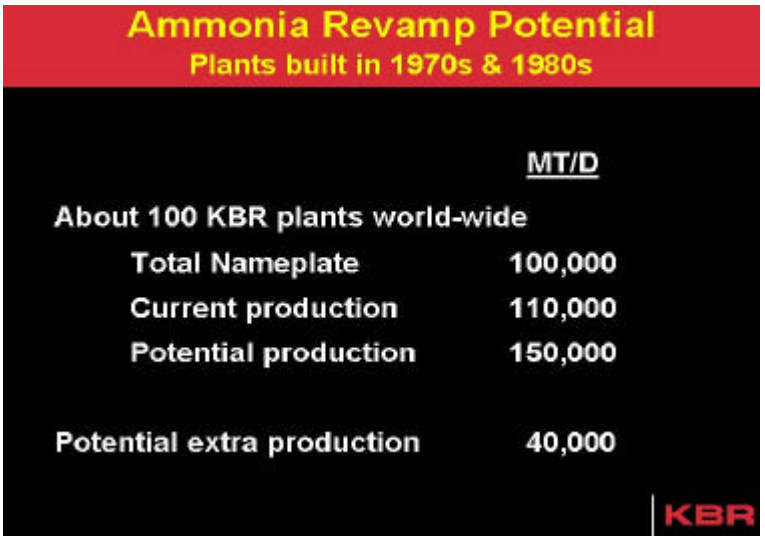


It turns out that plants of the 1970s and 1980s vintage were designed with conservative margins on equipment. This makes them relatively easy to debottleneck.

As time went by, two things happened. Contractors got more experience and the market shifted to lump sum contracts. This resulted in plants designed with less margin. So plants that came on-line from about 1990 onwards are much more difficult to economically revamp for more capacity.



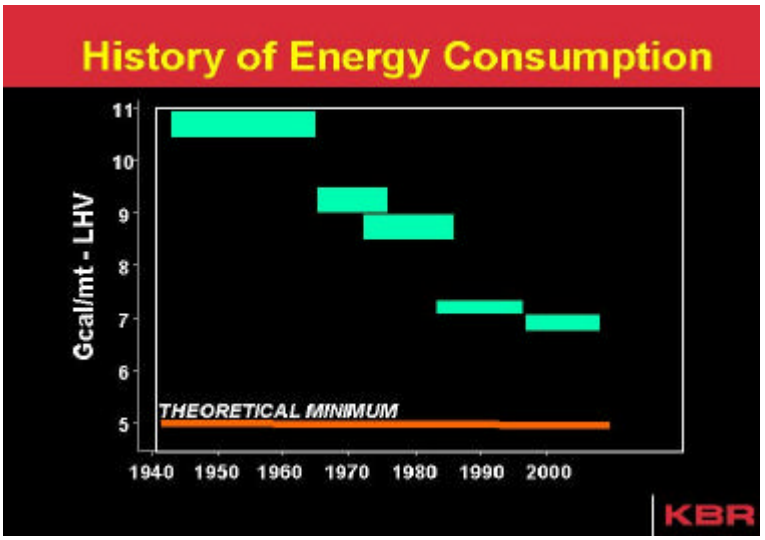
For this reason, capacity revamps have focused on plants built in the 1970s and 1980s. This slide illustrates the results from several such plants that KBR has studied in the past 2 years for their owners. Two of these studies have proceeded to the project stage.



The potential for additional ammonia capacity brought to market by revamping older KBR plants is about 40,000 mt/day. This is equivalent to about 13 million mt/year, or 10 percent of current demand.

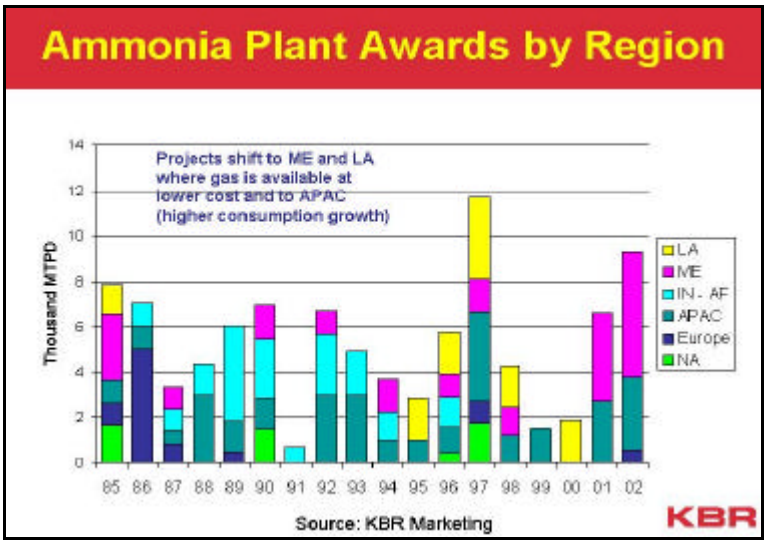
Now let's talk about the outlook for capacity addition through new plants. We will have a look at the factors that have been influencing owners when they buy a new plant.

CAPACITY INCREASES VIA NEW PLANTS



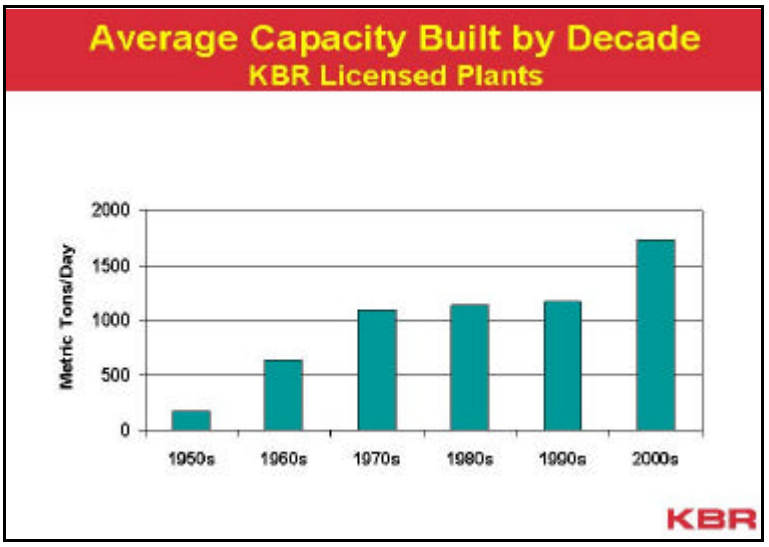
During the 1980s, owners looked for competitive advantage with new plants that were more efficient than the earlier vintage ammonia plants. Contractors successfully reduced the energy consumption from about 11 Gcal/mt to 7 Gcal/mt. This current level of energy consumption is pushing the theoretical minimum. Further improvements will be marginal with the present ammonia process technology.

Today plant operators need to look elsewhere to get comprehensive advantage.



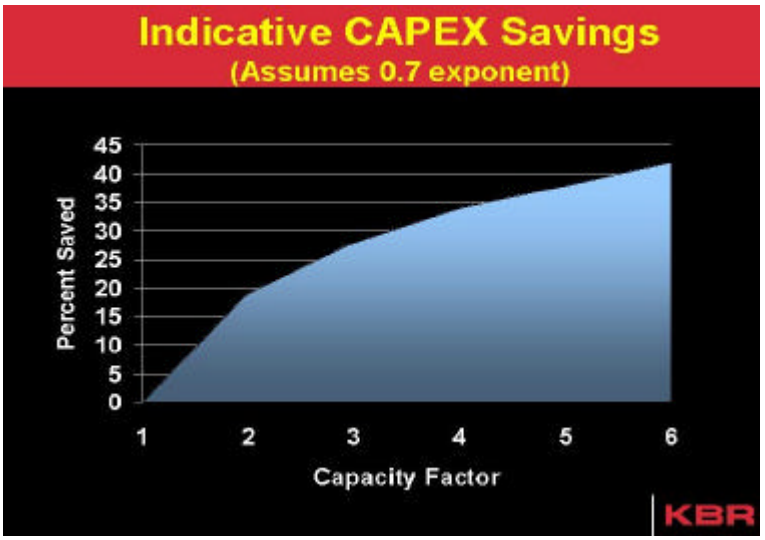
During the 1990s, owners sought competitive advantage by moving capacity to regions with low natural gas cost.

This graph shows the same new capacity data as shown earlier, but with a breadown by region. The trend of new capacity migrating to the Middle East, Asia-Pacific and Latin American regions stands out. Latin America, mainly Trinidad and Venezuela, plus the Middle East represent areas of low gas cost.



This slide shows the average capacity of plants licensed by KBR during each decade. You can see two steps changes in this graph. The first occurs in the 1960s with the introduction of the 1000 t/d plants. This capacity remained the standard through most of the 1990s.

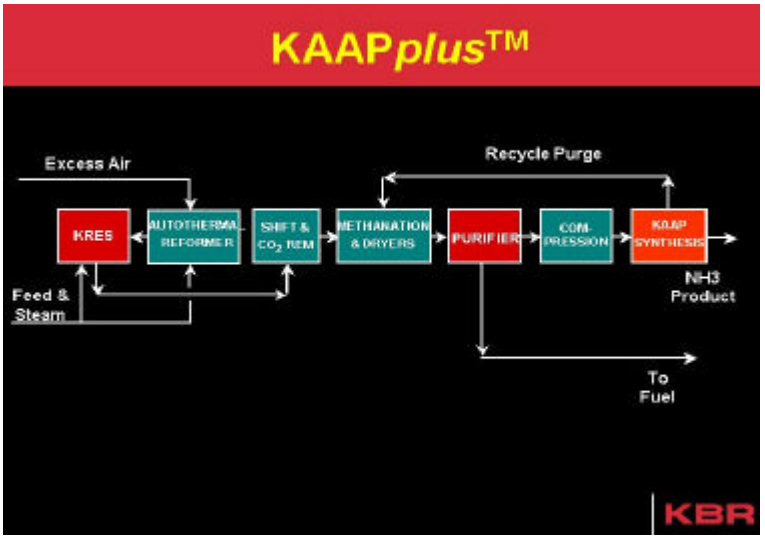
Recently we have seen a second step change. Recognizing that energy efficiency is nearing its limit, ammonia producers are now seeking economy of scale as the next opportunity for competitive advantage.



This slide gives an indication of the benefit of economy of scale. If we assume that plant cost varies with the capacity to the 0.7 power, then doubling the capacity would offer about 20 percent savings in capital cost charges (capital expenditures).

Trends in Maximum Capacity

- Ammonia plants currently in design have capacities in the range of 2000 to 2200 mt/day.
- KBR has turned in proposals for plants with capacities in the range of 3000 to 4000 mt/day.
- KBR internal studies have shown that a single train capacity of 5000 mt/day is possible.

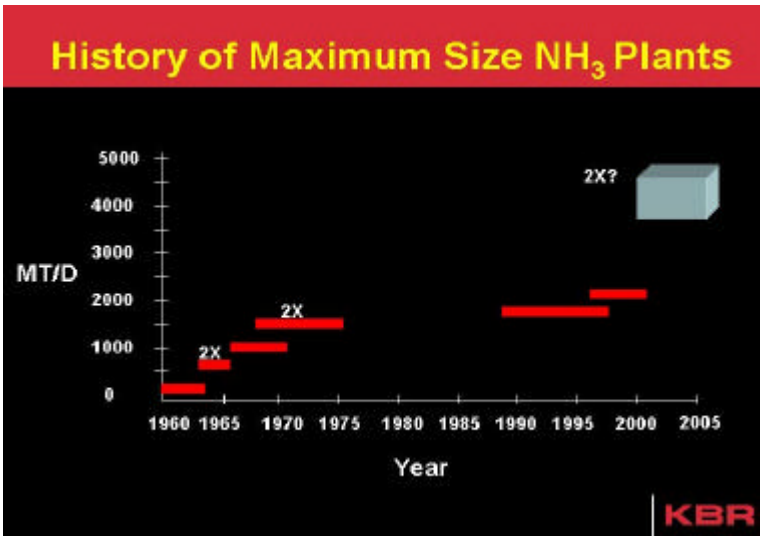


The key to KBR's ability to design a single train 5000 mt/day ammonia plant is our KAAP*plus*™ technology. This technology combines three proprietary elements – a reforming exchanger (KRES), a cryogenic Purifier and KAAP synthesis which takes place over a ruthenium promoted catalyst.

KRES eliminates the need for a primary reformer. Excess air in the autothermal reformer reduces the size of the KRES exchanger. Excess nitrogen along with all the methane and most of the argon are removed in the Purifier, thus providing a high purity make-up gas to the loop. This reduces the size of the equipment in the loop. These three technologies work together to enable large capacity plants.

Now I will summarize my comments on where KBR believes the ammonia business is heading.

SUMMARY



In the 1960s and early 1970s the ammonia industry witnessed a rapid scale up and build up of capacity. Twice, the maximum capacity was scaled up by a factor of two – first from 300 to 600-750 mt/day and then to 1000-1500 mt/day.

After 20 years of relatively constant maximum capacities, we are on the threshold of witnessing the next scale up. It appears that the scale up will again be about a factor of two.

Implications

- There will be fewer projects.
- Large amounts of ammonia (and urea) will suddenly come on the market.
- Projects will require more capital, leading to increased industry partnering to share risk.
- These "mega-capacity" projects will be in low gas cost areas.
- There will be some technical risk in the first 3000 – 4000 mt/day plant.
- There will be some logistics issues moving large volumes of product.
- Plants that are older, smaller, and in locations with high feed costs will continue to shut down.

Summary

- In the 1980s ammonia producers reduced energy consumption. This trend has reached its practical limit.
- In the 1990s we saw a shift of capacity to low gas cost areas. This trend will continue.
- Revamps of 1970s and 1980s vintage plants will continue.
- We are now witnessing a second step change in single-train capacity. The upper limit appears to be about 5000 mt/day.